WAKEBENCH. A new IEA Task for the Benchmarking of Wind Farm Flow Models

Rodrigo, J.S.; Moriarty, P.; Barthelmie, R.; Brand, A.; Ejsing Jørgensen, Hans

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IEA Wind - Task 31

WAKEBENCH: Benchmarking of wind farm flow models

wind power

Javier Sanz Rodrigo (CENER)

Patrick Moriarty (NREL)

Rebecca Barthelmie (Indiana Univ.)

Hans E. Jørgensen (Risø-DTU)

Arno J. Brand (ECN)

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Motivation

- Classical wind farm models, typically based on linearized and algebraic approximations, are being complemented with a large variety of numerical models based on Computational Fluid Dynamics (CFD)
  - ✓ More realistic description of the flow behavior around complex terrain/wind farm topologies
  - ✓ More degrees of freedom in the modeling chain → more flexibility for the developer and end-user
  - × More training/experience requirements
  - × More user-dependency
  - × Lack of traceability

- Need for quality-checked "best practice" procedures for…
  - ❑ The evaluation of the numerical models
  - ❑ The validation and verification strategy
  - ❑ The selection and definition of test cases for validation

- EU TPWind 3% Vision: Model uncertainties below 3% by 2030 regardless of site conditions → Realistically the vision is now around 30% → long way to go!

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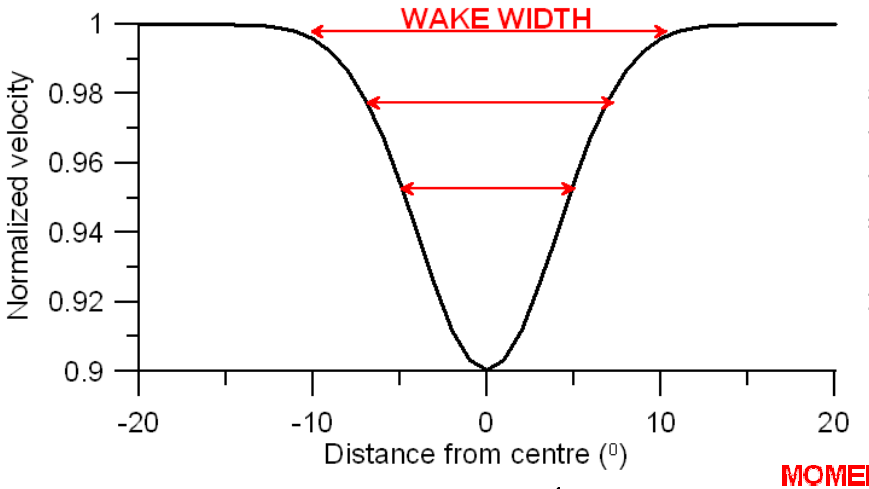
Main Objective

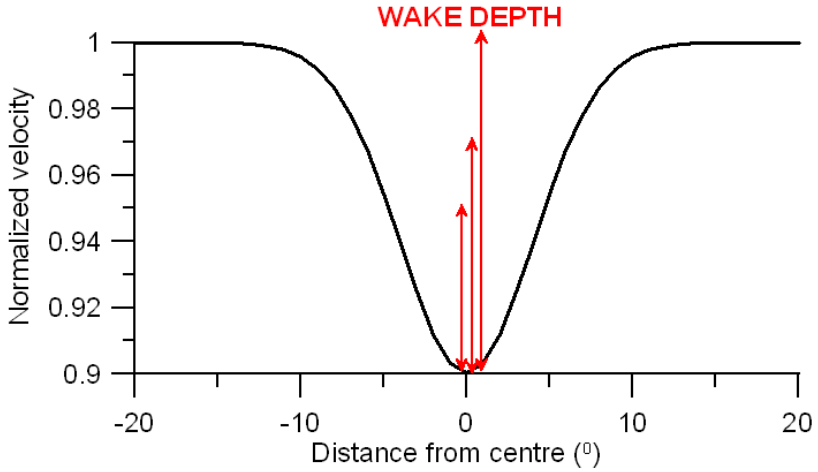
- To improve wind farm modeling techniques and provide a forum for industrial, governmental and academic partners to develop, evaluate and improve atmospheric boundary layer and wind turbine wake models for use in wind energy
  - from flat to complex terrain,
  - from single to multiple wakes,
  - both onshore and offshore,
  - using well defined test cases from the literature and test wind farms ("research" conditions) as well as from industrial sites ("real-life" conditions)

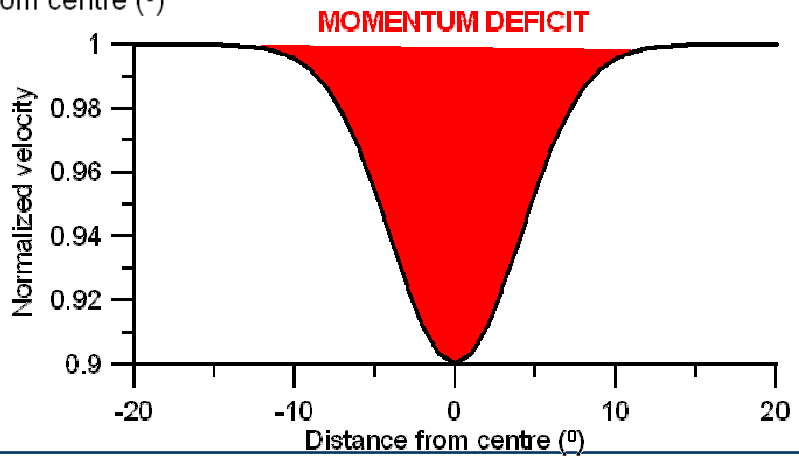
- Aligned with the activities of Working Group 2 of the EERA Wind Conditions sub-programme.
  - Investigation of the model chain
  - Evaluation of model performance and uncertainties using the data generated by WG1

Model Evaluation Procedures: Metrics

- What makes one modelling approach better than the other?
- Initial deliverable will be a consensus on metrics used for comparing data to simulations







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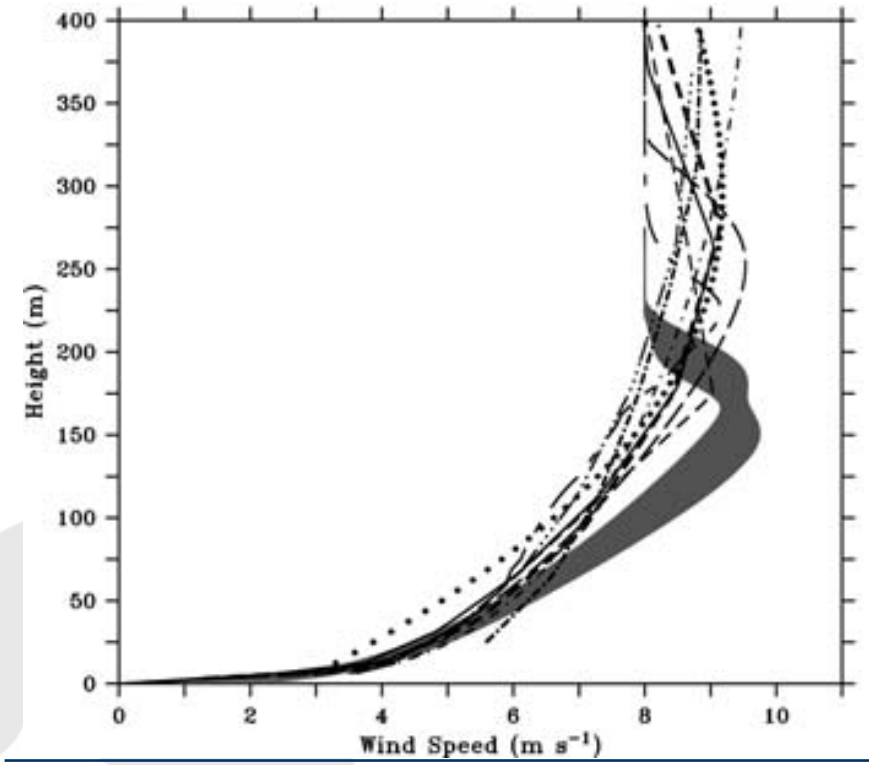
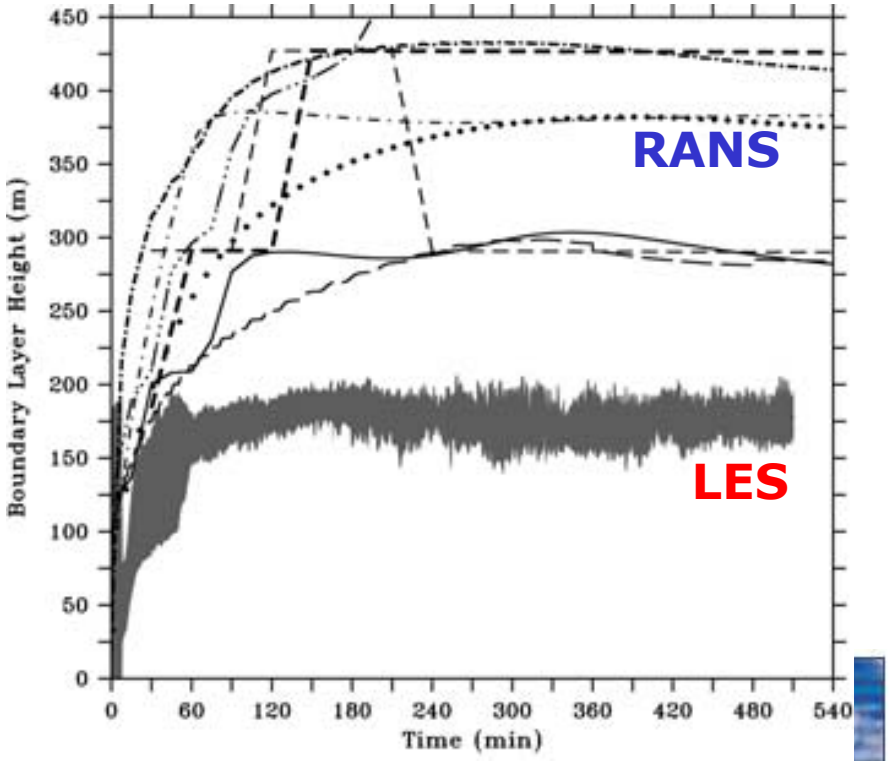
Test Cases. Example 1: ABL models

- Single-column model intercomparison for stably stratified Atmospheric Boundary Layer (ABL) (Cuxart et al., 2005)
  - ABL parameterizations from the major climate research centres
  - First-order (RANS-type) and LES turbulence closures
  - Very large dispersion of results!





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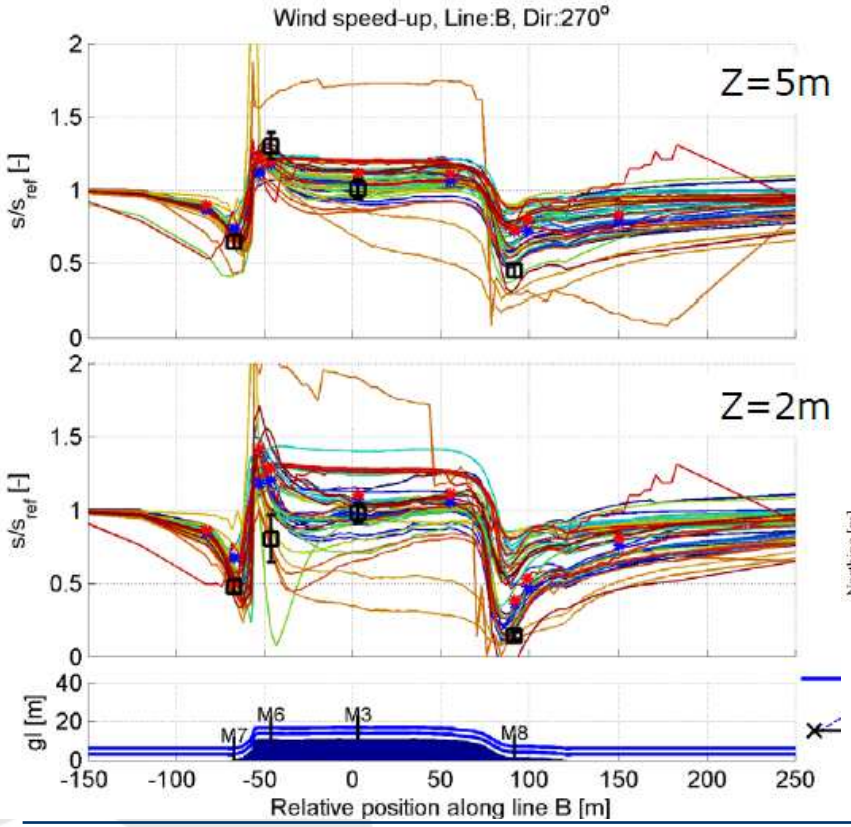
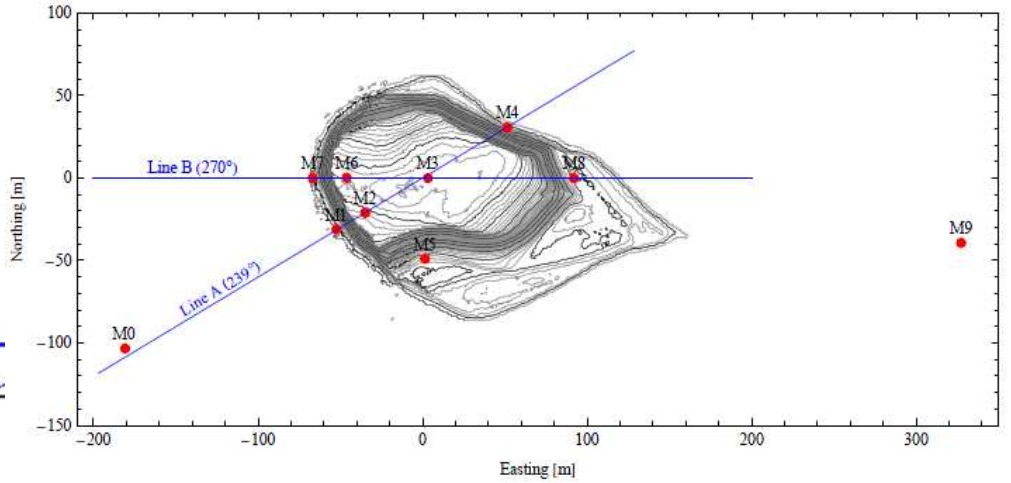
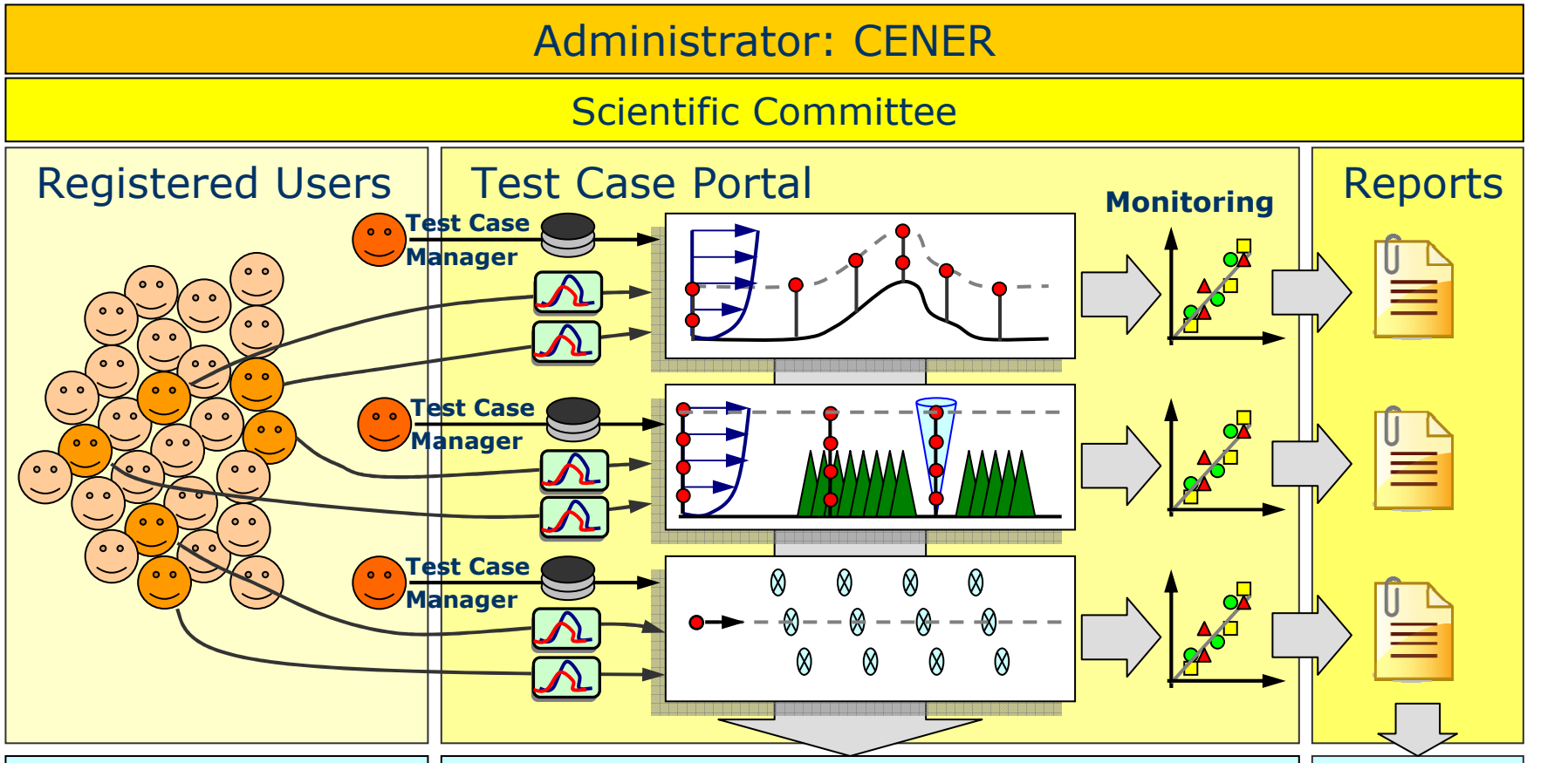
Test Cases. Example 2: Complex Terrain

- Bolund experiment and blind comparison (Bechmann et al., 2009)
  - Well defined boundary conditions
  - 52 model runs: RANS, LES and wind tunnel models
  - Very large dispersion of results! Errors in wind speed ~ 15%





"WINDBENCH" Web Portal



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Status and Outlook

- IEA Task 31 was approved by the IEA-Wind ExCo in October 2010
- The Task has two operating agents
  - Javier Sanz (CENER), to take the overall management of the Task and the "wind" programme
  - Patrick Moriarty (NREL), to manage the "wake" programme
- Now assembling participants from IEA-Wind countries
  - Australia, Austria, Canada, China, Denmark, European Comission, EWEA, Finland, Germany, Greece, Ireland, Italy, Japan, Korea, Mexico, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States
  - 28 expressions of interest received so far from 12 countries
- Negotiation with IEA members for budget allocation under way
- Task 31 to effectively start in the second half of 2011

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Avda. Ciudad de la Innovación, nº 7
31621 Sarriguren. Navarra (España)

Tel. +34 948 25 28 00
Fax. +34 948 27 07 74
Email. info@cener.com

www.cener.com

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